Grenze International Journal of Engineering and Technology, Jan Issue

Decentralized Replacement for Ride-Hailing Services: DECENOLAR

Abhay Bhardwaj[1], Arjun Dogra[2], Arya Kumari[3], Asmita Gauri[4] and Dr. Sumana M[5]
[1-5]Ramaiah Institute of Technology, Department of Information Science & Engineering, Bangalore, India
Email: 1ms18is005@gmail.com, 1ms18is136@gmail.com,1ms18is019@gmail.com, 1ms18is020@gmail.com, sumana.m@msrit.edu

***Abstract*—The idea is inspired by how giants such as Uber and OLA have monopolized/centralized all common transactions between the drivers and passengers. These "giants" collect as high as 25-30% of the ride charges paid by the rider to the driver as platform fees or usage charges.**
DECENOLAR aims to solve the above problem with a trustless, completely decentralized, and robust system provided to the user as a Decentralized Application (also popularly known as DAPP). In other words, users of the ride-hailing services will be able to operate/use an application similar in terms of the user journey to Uber/OLA, but with the added trustlessness and robustness of DAPPs.

***Index Terms*— Ride Sharing - Decentralized, Ethereum Blockchain, IPFS - InterPlanetary File Sharing System.**

I. INTRODUCTION

Over the past few years, ride-hailing giants have dominated this market with increasing demands. To make a living, many drivers from India's rural areas leave their hometowns. ride-hailing businesses impose excessive surge charges, and many other techniques are employed to maximize profit, resulting in driver exploitation. The life of a driver who works tirelessly for us to ensure that we get our trips on time is still in crisis, and they are under a lot of pressure to meet their daily expenses in large cities, with rising living costs, numerous debts, and pending loans, weekly and monthly trip targets to accomplish, and so on. Local taxi drivers have lost customers as a result of the ride-hailing businesses' enticing pricing.
In India alone, the taxi service sector is worth $10 billion. There are numerous ridesharing services on the market today. However, the majority of these systems are centralized and maintained by a third party, giving them the capacity to monitor aspects such as fare calculation and user data. In a system like this, privacy and trust are important considerations.

II. MOTIVATION

Any community's transportation system is essential. Consumers may now book a private or shared car with a few clicks using ride-hailing services, which are primarily based on the on-demand availability business model. These methods have grown more convenient than hailing a regular cab because payment is taken automatically from users' accounts.

Grenze ID: 01.GIJET.9.1.512_2

In India alone, the taxi service sector is worth $10 billion. There are numerous ridesharing services on the market today. However, the majority of these systems are centralized and maintained by a third party, giving them the capacity to monitor aspects such as fare calculation and user data. In a system like this, privacy and trust are important considerations.

Over the past few years, ride-hailing giants have dominated this market with increasing demands. To make a living, many drivers from India's rural areas leave their hometowns. ride-hailing businesses impose excessive surge charges, and many other techniques are employed to maximize profit, resulting in driver exploitation. The life of a driver who works tirelessly for us to ensure that we get our trips on time is still in crisis, and they are under a lot of pressure to meet their daily expenses in large cities, with rising living costs, numerous debts, and pending loans, weekly and monthly trip targets to accomplish, and so on. Local taxi drivers have lost customers as a result of the ride-hailing businesses' enticing pricing.

III. Literature Survey

In [1], In order to show how a decentralized system based on the blockchain can be created to track ride data, it suggests a specialized system called PEBERS: Practical Ethereum Blockchain-based Efficient Ride-Hailing Service. In this regard, smart contracts are also investigated for use in developing and deploying decentralized ride-hailing application capabilities like creating a ride, auto deposit transfer, cancel, and complete ride procedures. The trials reveal that the driver smart contracts included in the system use less gas, demonstrating that it is a more effective method than many others now in use with regard to passenger costs and driver profitability. This is an endeavor to provide smarter transportation in a society that is embracing the idea of the smart city. It also emphasizes how blockchain's decentralized data auditability, anonymity, and immutability have contributed to its outstanding recognition while resolving the difficulties described above.

[2] Discusses how the existing ride-sharing system, which is offered by numerous organizations, is centralized. It is a trust-based system with centralized servers to track every ride's specifics. This type of approach appears to be less transparent and raises issues with consumer and information security. The systems become less flexible and have questionable data integrity due to centralization. It attempts to put into place an alternative ride-sharing system that draws inspiration from blockchain, which serves as a shared database for keeping track of all transactions. Sending money to a network member is one of the simplest possible transactions. Additionally, as the application uses blockchain it eliminates the requirement of a third party and thus both the drivers and the riders can connect with each other directly.

[3] Demonstrates how the market for car sharing is always expanding and recently surpassed the popularity of owning a car. The traditional car-sharing system, on the other hand, is dependent on a centralized database server, which frequently invites hacker assaults or password leaks. Additionally, under a traditional car-sharing scheme, the proprietors of the vehicles may abuse client information. The ideal way to resolve these challenging problems, as demonstrated in today's many application cases, is to leverage blockchain technology. Blockchain offers clients unbreakable security since it is a decentralized, unchangeable, public ledger. The proposed solution's objective is to develop and put into use peer-to-peer short-term car-sharing applications based on blockchain and smart contracts. Smart contracts are implemented using the Solidity programming language. With the Ethereum blockchain, Solidity functions. The introduction of a peer-to-peer automobile sharing service without a central authority, which indicates a decrease in prices and an increase in data openness in that system, is the article's main innovation. The flexibility to support business-to-business (B2B) and business-to-customer (B2C) use cases is another benefit of token-based solutions.

[4] This paper is detailing how cab service aggregators currently conduct their daily business using a centralized manner. Depending on the firm, the user and the driver must adhere to different laws, rules, regulations, terms, and conditions. Additionally, the payment process for cab reservations must be handled through intermediaries or third-party companies. This becomes a problem as there are more parties engaged since there is less openness. Due to these drawbacks, blockchain technology has been thoroughly examined, and as a result, various ideas for ride-sharing architecture built on top of the blockchain have been made. The purpose of this essay is to contrast and compare these existing techniques. The primary goal of this paper is to shed light on the different methods in which the decentralized, transparent ideals of blockchain have been applied, as well as the motivations for doing so. The benefits and drawbacks of these techniques have been thoroughly examined and underlined in this article, along with details on how the blockchain modules and concepts are applied at various stages of the system.

[5] Describes how the fundamental definition of blockchain technology is a decentralized ledger of all transactions or digital events that have been shared across the participating entities. The owner of the vehicle

drives the passengers to their location as part of a ridesharing system. Today's market offers a wide variety of ridesharing services. However, the majority of these services are hosted by a third party and are centrally located. In such a system, privacy and trust are crucial issues. This study aims to develop a decentralized ridesharing application where all transactions, fare computation, matching, and data are recorded on a distributed ledger. All peers in the network will have access to the ledger. Decentralized matching of users with rides without the need of intermediaries or a centralized network makes the system transparent and dependable. Blockchain data is unchangeable. Therefore, in order to preserve security and guarantee user privacy, this technology is utilized to store rides and user information. Transformative improvements in terms of privacy and trust may result from the usage of blockchain in ride-sharing. The user's privacy is frequently jeopardized in ride-sharing networks in the name of availability. The user's data can be protected securely and will be unchangeable with the aid of blockchain.

In [6], it is discussed how in order to enable autonomous/self-driving vehicles to participate in a decentralized ride-sharing economy, this paper offers RiderS, a unique privacy-first decentralized self-driving ride-sharing ecosystem. RiderS' fundamental component is a self-sovereign biometric solution that uses computer vision to register and authenticate individuals using a privacy-first biometric authentication technique. In order to support a self-sustaining ride-sharing economy, it also suggests a revolutionary decentralized design. We provide a cutting-edge proof-of-matching geo-aware consensus technique for validating and rewarding self-driving cars. The fundamental idea is that each vehicle makes use of its internal processing power to authenticate transactions and participate in maintaining the ecosystem while earning rewards.

According to test results, an NVIDIA Jetson AGX Xavier development kit can do roughly 10K Matches per second (KMs). analyzed the accuracy of the biometric solution with high matching rates as well as the privacy concerns.

In [7], It is described how a variety of industrial sectors are projected to profit from the growing use of blockchain technology in IoT-enabled industries (Industry 4.0 and Industrial IoT). The game-changing capabilities offered by this technology are stated to be tamper-proof and robust record-keeping methods. There have been substantial investments in blockchain, as can be seen in the numerous case studies examined in this study. Despite scalability concerns, the old way of centralizing data sharing has been used in the industry for so long because it is regarded as safer than a decentralized approach. With blockchain providing answers for dealing with both security and integrity challenges, this is about to change. This paper surveys the most recent studies on the use of blockchain in several IIoT-specific businesses. In order to offer an abstract measure of acceptance in practice, various commercial implementations of blockchain in Industry 4.0 and IIoT are examined. The implementation obstacles experienced by each of these businesses are also discussed.

IV. Approach

Our Aim is to provide a completely decentralized Community-based Taxi Booking platform built on Ethereum Blockchain. The platform is available on the IPFS as a web application and users can make payments with Ethereum.

We are focused on giving riders back their old-fashioned independent taxi service along with the touch of the latest technology. Our app allows two types of users: riders and drivers. Riders create ride requests by providing some spatial data along with temporal constraints and based on some optimal metric and algorithms that calculate that, the request is routed to some Drivers who have the option to accept or reject the request until the temporal constraints are satisfied.

A user can use a wallet manager such as the Metamask installed in their browser and visit the web app, once a wallet is connected to the application the user can either choose to use the app to book cab rides or work as a driver and the “isDriver” flag is set to true or false accordingly.

The details of the previous rides are also shown in the history section of the app. The rider can then create a ride request by providing details like the current location and final destination and the fare is calculated as per the distance using Algorithm 1. The calculated fare once approved by the rider is confirmed and gets added to the “riderRequests” collection. Any driver who is active on the web app searches for the most suitable ride.

The driver’s current location is taken and the most suitable ride request is selected among the currently active “rideRequest” collection. The collection is updated prior to making the selection to purge ride requests which are older than one hour, then the ride whose source is closest to the driver is returned. Once the driver receives the most suitable ride, he can either accept or reject the request.

If the driver accepts the ride request, all the rider details, driver details, and ride details are clubbed together and sent for storage. The ride details are then checked in the “finalizedRides” mapping and if the ride request is

already confirmed by some other driver, the ride confirmation failed message is shown to the driver. If the ride request details are not found in the "finalizedRides" mapping, the ride details are stored in the "finalizedRides" mapping and the status is set to "ongoing".
The ongoing ride details are then sent to the "ongoingRides" collection with the "rideCompleted_confirmation_rider" and "rideCompleted_confirmation_driver" flags set to false. Once the ride is completed in the real world, both the rider and the driver confirms the ride as completed on the app, and the "rideCompleted_confirmation_rider" and "rideCompleted_confirmation-driver" flags are set to true. The ride details are then removed from the "ongoingRides" collection and moved to the "pastRides" collection.
Once the ride completion confirmation is sent, the ride status in the "finalizedRides" mapping is changed from "ongoing" to "complete". Transfer of the ride amount is then done from the rider to the driver. Here the GAS fee for the blockchain transaction is borne by the rider. Once the transaction is completed successfully, the confirmation notification is shown in the user's crypto wallet which is usually Metamask.
Given in Fig. 1 describes the high-level design overview of the decentralized web app consisting of an end user, a frontend, and the Ethereum blockchain, and the smart contracts with data storage.

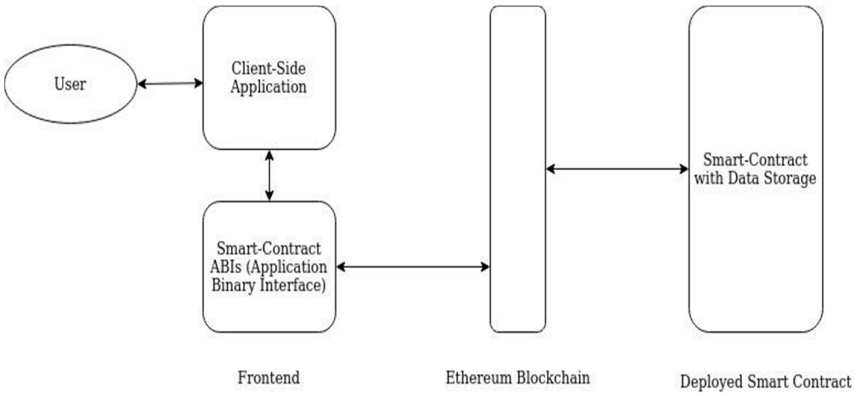

Figure 1 . High-level design of the application

V. IMPLEMENTATION

Algorithm 1 is used to calculate the optimal ride request to be sent to a Driver when he becomes available for accepting a ride request. The main idea behind the algorithm is to calculate the shortest distance between the driver's current location (Latdriver, Longdriver) and the pickup location of the ride request (Latpickup, Longpickup) along the curvature of the Earth using a simple algorithm.

Algorithm 1: Finding optimal Ride Request for the Driver is achieved by using the standard algorithm to find the shortest distance between two points on a sphere (for the sake of simplicity, the earth is assumed to be spherical)

Input:

- Coordinates of the pickup point (Lat_{pickup}, $Long_{pickup}$)
- Current location of the Driver (Lat_{driver}, $Long_{driver}$)

Output: Distance between the two inputs along the curvature of the earth.

1. Radius of the earth in km: R = 6371;
2. Convert the difference b/w latitudes and longitudes to

   Radian: $dLat = (Lat_{pickup} - Lat_{driver}) * (PI/180)$; $dLon = (Long_{pickup} - Long_{driver}) * (PI/180)$;
3. Calculate the value of 'a' as follows: a = sin(dLat/2)∗sin(dLat/2)+cos((lat1)∗(PI/180))∗cos((lat2)∗(PI/180))∗sin(dLon/2)∗sin(dLon/2);
4. Calculate the value of distance using the value 'a' obtained in the previous step: c = 2 ∗ Math.atan2(Math.sqrt(a), Math.sqrt(1 − a));
5. distance = R ∗ c;

The optimal Ride Request for the Driver is the ride with the shortest distance calculated above. That is done by running the above algorithm over each active ride request and returning the ride with the smallest calculated distance.

It should be noted that in the ideal implementation, instead of the shortest distance between the 2 pairs of coordinates, distance along a functioning/available transportation route should be used to calculate the optimal ride. As Solidity smart contracts do not provide any native support for accessing off-chain data (through HTTP calls, for instance), algorithm 1 was the only choice.

VI. Experiments and Results

Decentralized Autonomous Systems are the systems of the future, in comparison to systems that take private info, manipulate transactions between different types of users, and use it for targeted advertising, decentralized solutions are better in every aspect be it transparency or their ability to become completely autonomous.

TABLE I. GAS FEE TABLE FOR EACH TRANSACTION

Function	Gas fee/ Transaction (ETH)	INR/ Transaction
Contract creation/ deployment	0.0005516	77.81
initialize	0.0000903	12.74
fundRide	0.00003013	4.25
releaseFunds	0.00004187	5.91

VII. Conclusion

The systems of the future are decentralized autonomous systems because they are more transparent and have the capacity to become fully autonomous than systems that collect personal data, utilize it for targeted advertising, and interfere with transactions between different categories of users.
However, this technology still needs a few improvements before it can truly revolutionize the tech sector.
Decentralized apps and systems exist to give people services they can use without having to put their trust in anyone, and for this revolution to succeed, people must be educated enough to see this. TABLE

Future Work

Deploying the contract to the Ethereum mainnet and enabling real-world ether consumption. And set up a public Ethereum wallet, which is available for donations and can also be used in the next step.
In the true spirit of building a Decentralized Autonomous System, building a maintenance subsystem that would use projected monthly usage of cloud services(Mapbox, etc), and projected demand for rides, to calculate a percentage that could be included in each ride over the next month as a platform fee and be sent to the app's public Ethereum walled setup in the previous step. Also the public Ethereum wallet can be used to set up auto-pay for the cloud bills.
Revamping the smart contract to enforce more rules on the riders/drivers, to make the system even more trustless.

References

[1] German H. Flores Bathen, Luis Angel D. and Divyesh Jadav. Riders: Towards a privacy-aware decentralized self-driving ride-sharing ecosystem. In IEEE International Conference on Decentralized Applications and Infrastructures, pages 32–41. IEEE, 2020

[2] R. Gupta and S. Shanbhag. A Survey of Peer-to-Peer Ride Sharing Services using Blockchain. International Journal of Engineering Research Technology (IJERT)ISSN: 2278-0181 Vol. 10 Issue 08, 2021

[3] Rishabh Sah Atharva Date Pratik Rane Joseph, Richard and Amay Chugh. Blockwheels-a peer to peer ridesharing network. In 5th International Conference on Intelligent Computing and Control Systems (ICI-CCS), pages 166–171. IEEE, 2021.

[4] Renat Norderhaug Shahriar Badsha Shamik Sengupta Kudva, Sowmya and A. S. M. Kayes. Pebers: Practical ethereum blockchain based efficient ride hailing service. In 2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT), pages 422–428. IEEE, 2020.
[5] Kedia R.K. Balodia S. Kumar, R. and S.D. Suvvari. Decentralized Ride Sharing System. International Journal of Innovative Science and Research Technology ISSN No:-2456-2165, June -2021.
[6] Yong Qi Saiyu Qi Yue Li Hongyu Song Lu, Youshui and Yuhao Liu. Say no to price discrimination: decentralized and automated incentives for price auditing in ride-hailing services. ieee transactions on mobile computing. In IEEE transactions on Mobile computing, pages 1–18. IEEE, 2020.
[7] Atharva Hankare Rushi Redkar Narkhede, Chaitali and Smita Bharne. EtherRider: A Decentralized Intercity Ride-Sharing Platform using Block-Chain Technology. ITM Web of Conferences, vol. 44, p. 03023, 2022